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ORIGINAL ARTICLE

The influence of different doses of lithium additive in mixed feed on the balance of nitrogen in organism of goslings

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Recently it has been experimentally proved the vital necessity of lithium for the human organism, animals and plants, which was previously considered conditionally essential trace element. The discovery of biological features and the disclosure of biochemical mechanisms of lithium action were served as the basis for its use in veterinary and animal husbandry. In veterinary the preparation of lithium are successfully used for the treatment of various animal diseases, in poultry farming for the prevention and correction of "technological" stresses in poultry, increasing its productive qualities and improving the quality of meat products. Despite of the biochemical variety and practical importance of this trace element, lithium has not yet used enough in poultry feeding due to the lack of optimal norms of its introduction into feed. One of the criteria for evaluating of the nutritional usefulness of lithium, in determining the physiological needs of poultry in this trace element is the metabolism in the organism, in particular proteins. In the physiological experiment, which was carried out with 30-day goslings, the influence of adding of different doses of lithium in mixed feed on nitrogen balance in goslings organism was studied. It was found that the adding of lithium in the mixed feed in doses of 0.05; 0.1 and 0.15 mg/kg increases the intensity of metabolic processes in goslings, as a result are increasing of absorption, reducing of excretion and increasing of nitrogen deposition in the organism by 5.2–8.9%, that promotes the formation of higher productivity of goslings. According to the level of nitrogen deposition and assimilation, the poultry of fourth experimental group was differed favorably from its analogues from the control and other experimental groups, which were fed by mixed feed that had been enriched with lithium in a dose of 0.15 mg/kg. According to the results of one-dispersion analysis, the effect of this dose on nitrogen deposition in goslings organism amounted to 53.9%.
Keywords: Lithium; dose; mixed feed; goslings; organism; nitrogen deposition

Introduction

Poultry farming is the most dynamic part of the agricultural sector of the economy. It is capable in the next few years to radically improve the provision of high-quality dietary foods and strengthen the food security of many States. The global poultry sector has a stable annual growth trend as the demand for its products is driven by population growth, income growth and urbanization. Further development of the poultry industry could lead to the creation of new jobs in technology-related industries, in particular, feed-producing, processing and food industries and as a result it will contribute to a partial solution of the problem of unemployment in the world (Wahyono & Utami, 2018; Mottet & Tempio, 2017).

The results of numerous research and international experience in this industry show that the key of the maximum realization of the genetic potential of high productivity and preservation of livestock, as well as the rational use of feed resources and proper payment for feed by high quality products is the full feeding of poultry (Tufarelli et al., 2018; Leeson, 2008).

Today, animal husbandry has been enriched by data which suggests that further improvement of poultry feeding quality should be associated not so much with an increasing of metabolic energy rate and basic nutrients in mixed feed, but with an increasing in their biological value.

Modern mixed feed for farm poultry cannot be imagined without appropriate additives of trace elements. The results of numerous scientific researches are convincingly proved that the providing the poultry with the optimal amount of trace elements couldn't only improve the permeability of biological cell membranes and metabolism in the organism, to ensure the

normal functioning of the immune system and improve the productive performance, but also reduce product losses (Yatoo et al., 2013; Richards et al., 2010; Soetan, et al., 2010).
The trace elements which are contained in the organism in small quantities are performed unique structural, physiological, catalytic and regulatory functions at the biological, chemical and molecular levels. They are activate the action of many enzymes, hormones and other biologically active substances and thus indirectly affect the course of important biochemical reactions in the organism. As a part of biocatalysts, they take a part in oxidation-reduction processes, hematogenous, respiration, metabolism of proteins, fats, carbohydrates, vitamins and minerals, in biosynthesis of antibodies, stabilization of the integrity of cellular structures, neutralize and enhance the excretion of heavy metals from the organism (Prashanth et al., 2010; Mertz, 2013; Prasad & Gowda, 2005).
In different countries in mixed feed are mainly added the same trace elements and even approximately the same doses. However, the standards for the adding of trace elements are periodically reviewed in the light of new developments in science and practice. In recent years, in many countries of the world the searching of the optimal standards of new trace elements in mixed feed is conducted, because their significant positive impact on the poultry organism has been proved. According to scientists and specialists of the poultry industry, elements which have to be normalize included lithium.
Scientific studies of recent years have convincingly demonstrated that lithium is a biogenic ultramicroelement with a wide range of physiological and biochemical effects (Jakobsson et al., 2017; Roux & Dosseto, 2017). It has possesses antimicrobial (Stachelska, 2015; Lieb, 2004), antiviral (Qian et. al., 2018; Harrison et. al., 2007), antitumor (Wu et. al., 2013), antimetastatic (Maeng et. al., 2016), antistress (Galochkin et. al., 2018; Fisinin et. al., 2016), radioprotective (Tarumov & Antushevich, 2013), immunomodulatory (Lohitha & Singh, 2019) and antioxidant (Plotnikov et. al., 2016) effects. There is direct clinical evidence of the effect of lithium on osteogenesis (Tang et al. al., 2015).
For several decades lithium has been one of the most widely used and studied preparations for the treating of people with bipolar depression and other mental disorders (Malhi et al.) al., 2012).
The discovery of biological features and the biochemical mechanisms of lithium action were served as the basis for its use in veterinary and animal husbandry. In veterinary medicine, lithium preparations are successfully use for treating of various animal diseases, in particular, cyclic hematopoiesis (Bach & Gallicchio, 1990), thrombocytopenia (Leclerc et. al., 2010), myelosuppression (Abrams-Ogg, 2011) and estrogen-induced myelotoxicity of dogs (Sontas et. al., 2009).
In animal husbandry, particular in poultry farming, lithium began to be use recent. Different preparations of lithium are used for preventing and correcting of "technological" stresses during the sorting and transportation of poults (Abdullaev, 2015), during debeaking (Anosov & Miftahutdinov, 2015) and vaccination of chickens (Lukichjova, 2008). Lithium salts of inorganic and organic acids addedinto mixed feed for different species of poultry in order to increase their body weight, survival and feed conversion rate (Grybanova & Sobolev, 2015; Bachinskaja, 2009), to increase slaughter and meat qualities of meat poultry (Grybanova & Sobolev, 2013), improve organoleptic characteristics of meat (Lukichjova, 2011), its amino acids composition and biological value (Borovkov et. al., 2010). By aqueous solutions of various lithium concentrations are carried out pre-incubation aerosol treatment of chicken eggs with the aim of increasing their hatchability and poultry hatching (Belousova et. al., 2011).
Since it turned out that lithium activates the action of many enzymes and hormones and thus ensures their physiological function, some scientists have recently linked the increasing of the productive performance of poultry with the changes in the intensity of metabolism in their organisms. Today it is proved that under the influence of lithium improves digestibility of feed nutrients, in particular, protein, fat, fiber and NFE (Sobolev et. al., 2019).
Despite the biochemical diversity and practical importance of this trace element, lithium has not been yet sufficiently used in feeding poultry. This is due to the lack of differentiated standards of its adding into mixed feed for different types of poultry.
It is known that the appropriate response of a living organism to feed factors may be manifested in changes of the digestive processes associated with the degree of use of feed nutrients. Therefore, one of the criteria for evaluating the usefulness of lithium nutrition, in determining the physiological needs of poultry in this trace element is the metabolism in the organism. In evaluating the metabolism, in particular proteins, the level of nitrogen deposition in the organism is important as it most accurately determines the intensity of the organic substances synthesis and gains of the poultry (mainly due to muscle tissue build-up). In this regard, the aim of our research was to study the effect of additives of different lithium doses in mixed feed on the balance of nitrogen the goslings organism, which are growing for meat.

Materials and methods

The goslings of breed Danish Legart were included in the experiment. For conducting of the physiological experiment four groups of goslings were formed on the principle of analogues (n=5 in each group).The age of the goslings at the beginning of the experiment was 30 days. The groups were formed taking into account the body weight of goslings and their sex ratio. Physiological experiment included two periods: the previous one (3 days) and the main one (5 days). During the experiment, the goslings were kept in special cages which were adapted for collecting of poultry manure.
Under existing standards the feeding of the experimental goslings during the physiological experiment was carried out by dry full mixed feed, which was balanced by basic nutrients and biologically active substances. The goslings of the control group didn't receive the lithium additive into mixed feed. In the mixed feed of goslings in the experimental groups different doses of lithium were additionally added in accordance with the experimental scheme (Table 1). A source of lithium was its nanoaquachelated form.

Table 1. Scheme of physiological experiment.

Group	Lithium additive in mixed feed, mg/kg
1 control group	Complete feed – CF
2 experimental group	MF+0.05
3 experimental group	MF+0.10
4 experimental group	MF+0.15

During the main period (5 days) accurate records of feed consuming and manure excreting were carried out. The manure was collected twice a day: in the morning and in the evening. The collected manure was weighed and the average samples were taken for analysis. Selection of average samples of composed feed was carried out at the beginning of the main period according to the generally accepted method (DSTU ISO 6497:2005, 2008). The average samples of mixed feed were kept in plastic bags. Determination of nitrogen content in mixed feed and manure was carried out by the Kjeldahl method (DSTU ISO 5983-1:2014, 2015).

With mathematical processing the results of research was used the computer program of statistical processing of Microsoft Excel. The difference between the groups were evaluated by Student's test and Fisher's test (in the distribution analysis) and was considered reliable at $P<0.05$.

Results and discussion

The results of physiological experiment showed that the standard diet (FB) and diets with different doses of lithium provided a positive nitrogen balance in all experimental groups of goslings. It should also be noted that the adding of lithium additive in the standard diet of goslings had a positive impact on the deposition of nitrogen in their organism (Table 2).

Table 2. Average daily balance of nitrogen in the organism of goslings, $\left(\overline{X} \pm S_{\overline{X}}, n=5\right)$.

Indicator	Group			
	1 control	2 experimental	3 experimental	4 experimental
Taken with feed, g	7.92 ± 0.031	7.98 ± 0.038	7.96 ± 0.059	7.95 ± 0.054
Allocated with manure, g	5.23 ± 0.072	5.15 ± 0.054	5.04 ± 0.079	5.02 ± 0.117
Absorbed by the organism: g	2.69 ± 0.054	2.83 ± 0.062	2.92 ± 0.085*	2.93 ± 0.078*
% to accepted	33.9	35.5	36.7	36.9

Note. The probability of the difference between control and experimental groups Student's t-test *-$P<0.05$.

Thus, goslings of the experimental groups with almost the same adding of nitrogen in feed showed a tendency to reduce its excretion with manure by 1.5%, 3.6 and 4.0% This to some extent affected the absolute values of nitrogen content in the organism which in the goslings of experimental groups were 5.2–8.9% higher than in the goslings of the control group (2.69 g). However, the difference was statistically significant ($P<0.05$) only in the third and fourth experimental groups, where goslings have been taking advantage over the goslings of the same age of the control group by 0.19 and 0.23 g.

In the experimental groups the level of nitrogen assimilation in goslings organism also increased, but by a smaller amount than its deposition. The difference compared to the control group (which had this figure of 33.9%) was 1.6%, 2.8 and 3.0%, in favor of the experimental groups.

We used one of the types of stochastic analysis (dispersion analysis) in order to evaluate the scattering of possible values of a random variable around its mean value, as well as to identify and measure the strength of the correlations between individual levels of the factor and effective feature. We are determined how significant were the identified differences in nitrogen deposition in the goslings organism and what is the impact on them of different doses of lithium (Table 3).

Table 3. The effect of the influence of different lithium doses on nitrogen deposition in goslings organism.

Lithium dose, mg/kg	η^2_x	%	F (n_1=1; n_2=8)
0.05	0.364	36.4	4.57
0.1	0.480*	48	7.38
0.15	0.539*	53.9	9.37

Note. The probability of a difference by the Fisher test: *-$P<0.05$.

The results of one-factor dispersion analysis showed that the most significant effect on the deposition of nitrogen in goslings organism has a lithium in dose of 0.15 mg/kg. Thus, the effect of this dose on the effective feature was 53.9%($P<0.05$). On the

deposition of nitrogen in goslings organism also quite high (48.0%) and reliable (P<0.05) influence had a lithium dose of 0.1 mg/kg. The impact of lithium dose of 0.05 mg/kg on the effective feature was the lowest (36.4%) and statistically insignificant.

The analysis of growth rates of goslings during the physiological experiment allowed detecting that all researched doses of lithium had a positive influence on the body weight of goslings, which was caused by increasing of deposition and assimilation of nitrogen in goslings organism (Figure 1).

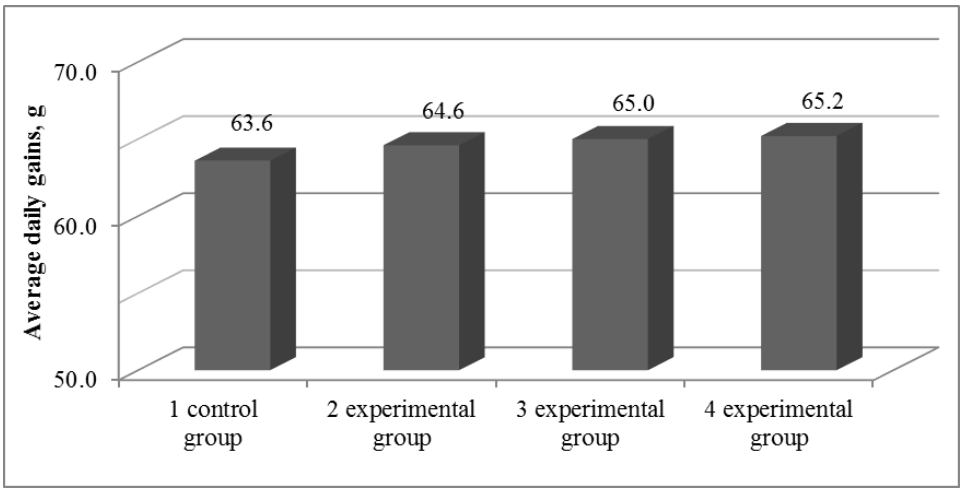

Figure 1. Average daily gains of goslings during the period of physiological experiment.

During the physiological experiment the highest average daily gains had goslings of the fourth experimental group (65.2 g). The difference compared to the control group was 2.5%. The goslings of the second and third experimental groups had the average daily gains slightly lower compared to the fourth group, however, their gains were higher compared to the control group by 1.6 and 2.2%.

There is no data in the literature concerning the deposition and assimilation of nitrogen in goslings organism depending on the level of lithium in the mixed feed. However, it should be noted that our results do not contradict the general trend of the positive effect of lithium additives on the nitrogen balance in organism of other species of farm animals. So, the balance experiment with pregnant sows showed, that the adding of lithium chloride to their diet led to increasing of nitrogen deposition in the bodies of animals of the experimental groups by 3.7 to 8.8%, including 1.2% to 2.8% from the accepted (Golushko et. al., 2010).

In our opinion, lithium additives can promote to the activation of mechanisms of elements transportation through the small intestine mucosa, and as a result the absorption increases, excretion reduces and deposition of substances in poultry organism increases too. The mechanisms of absorption of all substances in the intestine of poultry have not yet been fully clarified. In recent years, the concept of participation in the process of absorption of special transport-type substrate-binding proteins that increase the transfer of nutrients and biologically active substances from the enteric environment to the internal one has been developed. It is assumed that they reduce the interaction of nutrient substrates with the structural elements of over epithelial mucosal layer and its other components that do not perform a transport function. In favor of the possible role of lithium in the transport process indicates the increasing of transport proteins in blood serum of broilers: pre-albumins, albumins, transferrins, ceruloplasmin (Lukicheva, 2009; Kutishhev, 2006). The data obtained by Russian scientists' allowes to suggest that lithium increases the synthesis of transport proteins, expands the zone of their functional activity and thereby indirectly affects the absorption of feed nutrients.

Conclusion

It was found that the adding of lithium in mixed feed in doses of 0.05; 0.1 and 0.15 mg/kg increases the intensity of metabolic processes in goslings organism and as a result the absorption and nitrogen deposition increase, excretion reduces by 5.2–8.9%, which promotes the formation of higher productivity of goslings. By the level of nitrogen deposition and assimilation the poultry of fourth experimental group was differed significantly from the control and other experimental groups of goslings which were fed by mixed feed enriched with lithium at the rate of 0.15 mg/kg.

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